

AWARD NUMBER: W81XWH-15-2-0005

TITLE: Can a Canine Companion Modify Cardiac Autonomic Reactivity and Tone in PTSD?

PRINCIPAL INVESTIGATOR: Steven H. Woodward

RECIPIENT: Palo Alto Veterans Institute for Research

Palo Alto, CA 94304

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PREPARED FOR: U.S. Army Medical Research and Materiel Command
Fort Detrick, Maryland 21702-5012

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13. SUPPLEMENTARY NOTES					
14. ABSTRACT Planned data acquisition continues documenting the impact of a Service Animal Training Intervention on U.S. Military Veterans in treatment for chronic severe PTSD. Enrollment has been slower than planned; however, we are on track to accrue 80% of our planned intensive and non-dog completers due to extension of the recruitment period and lower than expected withdrawals. To summarize across published and preliminary results, canine companionship is associated with improved subjective mood, modification of attentional bias away from negative and toward positive stimuli, attenuated defense responses, and modest reductions in waking heart rate. To date, effects on sleep have not been observed.					
15. SUBJECT TERMS- Posttraumatic stress disorder, animal-assisted therapy, autonomic regulation, autonomic reactivity, mood, sociality, social cognition, sleep, ambulatory monitoring, defense response, facial affect					
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- 1. INTRODUCTION:** Narrative that briefly (one paragraph) describes the subject, purpose and scope of the research.

The subject of this research is the impact of canine companionship on cardiac autonomic regulation, mood, social experience, and social cognition in U.S. Military Veterans undergoing inpatient treatment for deployment-related posttraumatic stress disorder. Its purpose is to confirm or disconfirm in such Veterans the positive impacts of canine companionship that have been reported in civilian samples. Its scope is the inpatient treatment context; however, its results may have implications for less severely affected populations and similar but less intensive interventions.

- 2. KEYWORDS:** Provide a brief list of keywords (limit to 20 words).

Posttraumatic stress disorder, animal-assisted therapy, autonomic regulation, autonomic reactivity, mood, sociality, social cognition, sleep, ambulatory monitoring, defense response, facial affect

- 3. ACCOMPLISHMENTS:** The PI is reminded that the recipient organization is required to obtain prior written approval from the awarding agency Grants Officer whenever there are significant changes in the project or its direction.

What were the major goals of the project?

List the major goals of the project as stated in the approved SOW. If the application listed milestones/target dates for important activities or phases of the project, identify these dates and show actual completion dates or the percentage of completion.

The major goals for this project were to perform strong tests of a set of hypotheses relating canine companionship to autonomic regulation, social experience, and social cognition.

What was accomplished under these goals?

For this reporting period describe: 1) major activities; 2) specific objectives; 3) significant results or key outcomes, including major findings, developments, or conclusions (both positive and negative); and/or 4) other achievements. Include a discussion of stated goals not met. Description shall include pertinent data and graphs in sufficient detail to explain any significant results achieved. A succinct description of the methodology used shall be provided. As the project progresses to completion, the emphasis in reporting in this section should shift from reporting activities to reporting accomplishments.

The major goals for the third 12 months of this 4-year project were to recruit and test 164 participants. As described below, our recruitment stands at 74% of projected for the intensive limb of the design and 86% of the non-intensive limb. Ongoing efforts to remediate recruitment into the intensive limb are detailed below.

Enrollment since recruitment began in April 2015:

	Actual (n)	SOW target to date	SOW target final
Total Enrolled	153	204 (75%)	242 (63%)
Dog (intensive)	49	66 (74%)	80 (61%)
Non-dog	104	121 (86%)	160 (65%)
Total Completed	131	164 (80%)	200 (66%)
Dog (intensive)	39 [+1 current]	54 (72%)	60 (65%)
Non-dog	91	110 (83%)	140 (65%)

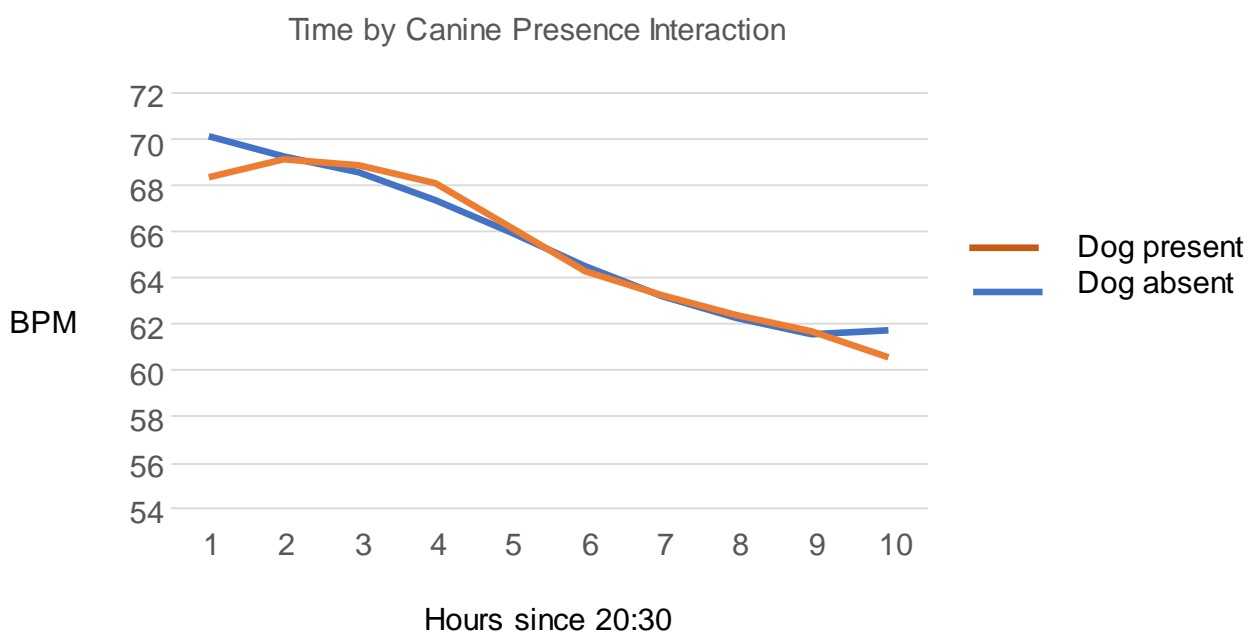
Withdrawals (April 2015 – January 2018):

	Actual n (% of enrolled)	SOW expected to date n (% of enrolled)	Withdrawal reasons
Total Withdrawals	20 (13%)	41 (20%)	
Dog (intensive)	10 (20%)	20 (30%)	5 changed mind; 5 discharged early from clinical program
Non-dog	10 (10%)	12 (10%)	4 changed mind; 3 discharged early from clinical program; 2 clinically contraindicated; 1 ineligible

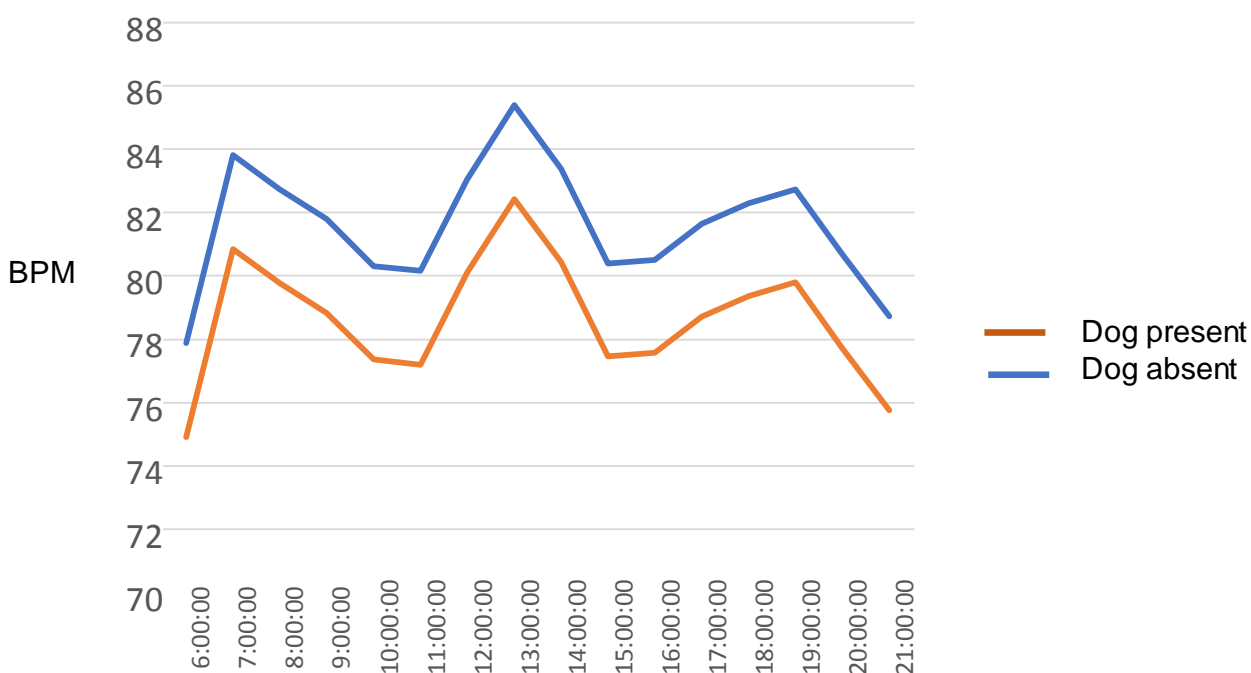
There have been no AE, SAEs, or UPs.

We have continued to perform interim analyses of data as they are acquired, and to publish them when appropriate. We have just submitted our second journal article, Miller et al, *Prospective study on subjective and objective predictors of trauma-related disturbed dreaming reports*. Based upon the intensive longitudinal collection of up to six weeks of objective mattress actigraphic data combined with morning reports endorsing the presence/absence of disturbing dreams, these data have enabled the most intensive analysis yet performed of predictors of disturbing dreams in Veterans or civilians with posttraumatic stress disorder. Along with presence/absence of service canine, we considered prior morning dream reports, prior day negative mood, actigraphic sleep efficiency, sleep period respiratory sinus arrhythmia, and apnea-hypopnea index (AHI; measured once) over four to six weeks of recording. Combining multiple imputation with logistic mixed-effects modeling, and we detected two significant independent effects on morning reports of disturbed dreaming in Veterans with chronic severe PTSD. The first was an elevated AHI. The second was reduced prior-night respiratory sinus arrhythmia. The association of elevated AHI with trauma-related nightmares replicates the findings of Krakow. Elevated AHI is already known to be modifiable risk factor for a number of conditions statistically associated with PTSD, including cardiac disease, obesity/metabolic syndrome, and motor vehicle accidents. The observed association of reduced sleep period respiratory sinus arrhythmia (RSA) with increased morning reports of disturbed dreaming is novel. The modifiability of nocturnal RSA, and any resultant improvement in disturbed dreaming, will need to be determined by future studies. Contrary to the many anecdotal reports from PTSD patients of reduced nightmares when they are accompanied by a service dog, we found no such effect in our sample.

Consistent with our null findings regarding the impact of canine companionship on morning nightmare reports, we have observed, to date, no main effect of canine companionship on sleep heart rate. We are in the process of upgrading our modeling of this medically consequential index to include effects of time-of-night and time-since-sleep-onset, as well as sleep quality, AHI, and BMI. While a canine presence x time of night interaction suggests that the early and late margins of the sleep period, when sleepers may be relatively cognizant of their surroundings, are associated with reduced heart rate when the dog is present, the effect is not apparent during the bulk of the sleep period.



This observation contrasts with our preliminary findings regarding waking heart rate which appears to be significantly lower on days accompanied by service dogs despite a small increase in activity.



What opportunities for training and professional development has the project provided?

If the project was not intended to provide training and professional development opportunities or there is nothing significant to report during this reporting period, state “Nothing to Report.”

Describe opportunities for training and professional development provided to anyone who worked on the project or anyone who was involved in the activities supported by the project. “Training” activities are those in which individuals with advanced professional skills and experience assist others in attaining greater proficiency. Training activities may include, for example, courses or one-on-one work with a mentor. “Professional development” activities result in increased knowledge or skill in one’s area of expertise and may include workshops, conferences, seminars, study groups, and individual study. Include participation in conferences, workshops, and seminars not listed under major activities.

Nothing to report

If there is nothing significant to report during this reporting period, state “Nothing to Report.”

Describe how the results were disseminated to communities of interest. Include any outreach activities that were undertaken to reach members of communities who are not usually aware of these project activities, for the purpose of enhancing public understanding and increasing interest in learning and careers in science, technology, and the humanities.

We have used journal articles and conference presentations to disseminate data from this study. These are listed below.

What do you plan to do during the next reporting period to accomplish the goals?

If this is the final report, state “Nothing to Report.”

Describe briefly what you plan to do during the next reporting period to accomplish the goals and objectives.

During the next reporting period, data acquisition and processing will continue as originally proposed. When and if obtained, additional positive results deemed reliable and replicable will be submitted for publication. Analyses of effects on sleep and startle reactivity are underway.

- 4. IMPACT:** Describe distinctive contributions, major accomplishments, innovations, successes, or any change in practice or behavior that has come about as a result of the project relative to:

What was the impact on the development of the principal discipline(s) of the project?

If there is nothing significant to report during this reporting period, state “Nothing to Report.”

Describe how findings, results, techniques that were developed or extended, or other products from the project made an impact or are likely to make an impact on the base of knowledge, theory, and research in the principal disciplinary field(s) of the project. Summarize using language that an intelligent lay audience can understand (Scientific American style).

It is still premature to attribute any changes in the practice of providing service animals to Veterans or in the conduct in animal-assisted therapy to this project.

What was the impact on other disciplines?

If there is nothing significant to report during this reporting period, state “Nothing to Report.”

Describe how the findings, results, or techniques that were developed or improved, or other products from the project made an impact or are likely to make an impact on other disciplines.

Nothing to report.

What was the impact on technology transfer?

If there is nothing significant to report during this reporting period, state “Nothing to Report.”

Describe ways in which the project made an impact, or is likely to make an impact, on commercial technology or public use, including:

- *transfer of results to entities in government or industry;*
- *instances where the research has led to the initiation of a start-up company; or*
- *adoption of new practices.*

Nothing to report.

What was the impact on society beyond science and technology?

If there is nothing significant to report during this reporting period, state “Nothing to Report.”

Describe how results from the project made an impact, or are likely to make an impact, beyond the bounds of science, engineering, and the academic world on areas such as:

- *improving public knowledge, attitudes, skills, and abilities;*
- *changing behavior, practices, decision making, policies (including regulatory policies), or social actions; or*
- *improving social, economic, civic, or environmental conditions.*

Nothing to report. All findings are preliminary.

5. **CHANGES/PROBLEMS:** The Project Director/Principal Investigator (PD/PI) is reminded that the recipient organization is required to obtain prior written approval from the awarding agency Grants Officer whenever there are significant changes in the project or its direction. If not

previously reported in writing, provide the following additional information or state, “Nothing to Report,” if applicable:

Changes in approach and reasons for change

Describe any changes in approach during the reporting period and reasons for these changes. Remember that significant changes in objectives and scope require prior approval of the agency.

There are no changes in objectives or scope.

Actual or anticipated problems or delays and actions or plans to resolve them

Describe problems or delays encountered during the reporting period and actions or plans to resolve them.

As we described at the recent MOMRP review, and in communications with our past and current science officers, we have experienced significant challenges recruiting participants into the intensive limb of our study since mid-summer, 2016. The shortage of service dogs contributing to this problem has been alleviated. The remaining constraint on recruitment derives from the permanently reduced census of the Trauma Recovery Program. We continue to facilitate communications between the Paws for Purple Hearts and TRP staffs in order to maximize patient flow into the Service Animal Training Intervention from whence interested patients may be recruited into our study. While it may be difficult to achieve 100% of the projected total sample of 60 completers for the intensive limb of the design, we believe that at least 80% of the planned sample is achievable. An important factor here is the unexpectedly low rate of withdrawals from our study. As described in an earlier report, we will also extend recruitment past the original stop date (July, 2018). We continue to believe the study will remain robustly powered. As noted previously, per standard procedure, we estimated sample sizes based on published studies. These estimates focused on the most medically consequential outcomes, baseline heart rates during waking and sleep. What we could not account for in those power estimates was the impact of the unprecedented data volumes provided by our novel technologies. That is, while the published findings regarding the impact of canine companionship on baseline heart rate were based on minutes of recording, our use of mattress actigraphy and single-patch ambulatory ECG enable us to acquire near 24-hour recordings for 20-40 days/nights. The greatly enhanced reliability of the resulting heart rate estimates should, in turn, substantially increase effective power. The preliminary analyses of sleep heart rate described above support this proposition.

Significant changes in use or care of human subjects, vertebrate animals, biohazards, and/or select agents

Describe significant deviations, unexpected outcomes, or changes in approved protocols for the use or care of human subjects, vertebrate animals, biohazards, and/or select agents during the reporting period. If required, were these changes approved by the applicable institution committee (or equivalent) and reported to the agency? Also specify the applicable Institutional Review Board/Institutional Animal Care and Use Committee approval dates.

Significant changes in use or care of human subjects

None.

Significant changes in use or care of vertebrate animals.

Not applicable.

Significant changes in use of biohazards and/or select agents

Not applicable.

6. Publications, conference papers, and presentations

Report only the major publication(s) resulting from the work under this award.

- **Journal publications.** *List peer-reviewed articles or papers appearing in scientific, technical, or professional journals. Identify for each publication: Author(s); title; journal; volume; year; page numbers; status of publication (published; accepted, awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).*

Woodward, S. H., Jamison, A. L., Gala, S., & Holmes, T. H. (2017). Canine companionship is associated with modification of attentional bias in posttraumatic stress disorder. *PloS one*, 12(10), e0179912.

Miller K.E., Jamison, A.L., Gala, S. & Woodward, S.H. Prospective study on subjective and objective predictors of trauma-related disturbed dreaming reports. (*submitted*)

- **Books or other non-periodical, one-time publications.** *Report any book, monograph, dissertation, abstract, or the like published as or in a separate publication, rather than a periodical or series. Include any significant publication in the proceedings of a one-time conference or in the report of a one-time study, commission, or the like. Identify for each one-time publication: Author(s); title; editor; title of collection, if applicable; bibliographic information; year; type of publication (e.g., book, thesis or dissertation); status of publication (published; accepted, awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).*

Nothing to report.

- **Other publications, conference papers, and presentations.** *Identify any other publications, conference papers and/or presentations not reported above. Specify the status of the publication as noted above. List presentations made during the last year*

(international, national, local societies, military meetings, etc.). Use an asterisk (*) if presentation produced a manuscript.

Woodward, S. H., Jamison, A. L., Gala, S., & Arsenault, N. (2017). Posttraumatic stress disorder, canine companionship, and sleep: Preliminary findings. Paper presented at the Annual meeting of the Associated Professional Sleep Societies, Boston, MA.

Woodward, S. H., Jamison, A., Gala, S., Arsenault, N.J., Righi, S., Lawlor, C. (2017) Canine companionship is associated with attenuated responses to loud tones in PTSD. Presentation at the International Society for Traumatic Stress Studies, November, Chicago, IL.

- **Website(s) or other Internet site(s)**

List the URL for any Internet site(s) that disseminates the results of the research activities. A short description of each site should be provided. It is not necessary to include the publications already specified above in this section.

Nothing to report.

- **Technologies or techniques**

Identify technologies or techniques that resulted from the research activities. In addition to a description of the technologies or techniques, describe how they will be shared.

Nothing to report.

- **Inventions, patent applications, and/or licenses**

Identify inventions, patent applications with date, and/or licenses that have resulted from the research. State whether an application is provisional or non-provisional and indicate the application number. Submission of this information as part of an interim research performance progress report is not a substitute for any other invention reporting required under the terms and conditions of an award.

Nothing to report.

- **Other Products**

Identify any other reportable outcomes that were developed under this project. Reportable outcomes are defined as a research result that is or relates to a product, scientific advance, or research tool that makes a meaningful contribution toward the

understanding, prevention, diagnosis, prognosis, treatment, and/or rehabilitation of a disease, injury or condition, or to improve the quality of life. Examples include:

- *data or databases;*
- *biospecimen collections;*
- *audio or video products;*
- *software;*
- *models;*
- *educational aids or curricula;*
- *instruments or equipment;*
- *research material (e.g., Germplasm; cell lines, DNA probes, animal models);*
- *clinical interventions;*
- *new business creation; and*
- *other.*

Nothing to report.

7. PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS

What individuals have worked on the project?

Provide the following information for: (1) PDs/PIs; and (2) each person who has worked at least one person month per year on the project during the reporting period, regardless of the source of compensation (a person month equals approximately 160 hours of effort). If information is unchanged from a previous submission, provide the name only and indicate “no change.”

Example:

<i>Name:</i>	<i>Mary Smith</i>
<i>Project Role:</i>	<i>Graduate Student</i>
<i>Researcher Identifier (e.g. ORCID ID):</i>	<i>1234567</i>
<i>Nearest person month worked:</i>	<i>5</i>
 <i>Contribution to Project:</i>	 <i>Ms. Smith has performed work in the area of combined error-control and constrained coding.</i>
<i>Funding Support:</i>	<i>The Ford Foundation (Complete only if the funding support is provided from other than this award).</i>

Effort listed for PI/Senior Key Personnel reflects the approved proposed effort. Effort for staff is pro-rated to reflect actual effort worked during this reporting period.

Name: Steven Woodward
 Project Role: Principal Investigator
 Nearest person month worked: 2
 No change

Name: Andrea Jamison
 Project Role: Coordinator
 Nearest person month worked: 12
 No change.

Name: Sasha Gala
 Project Role: Research Assistant
 Nearest person month worked: 11
 No change.

Name: Diana Villaseñor
 Project Role: Research Assistant
 Nearest person month worked: 1

Has there been a change in the active other support of the PD/PI(s) or senior/key personnel since the last reporting period?

If there is nothing significant to report during this reporting period, state “Nothing to Report.”

If the active support has changed for the PD/PI(s) or senior/key personnel, then describe what the change has been. Changes may occur, for example, if a previously active grant has closed and/or if a previously pending grant is now active. Annotate this information so it is clear what has changed from the previous submission. Submission of other support information is not necessary for pending changes or for changes in the level of effort for active support reported previously. The awarding agency may require prior written approval if a change in active other support significantly impacts the effort on the project that is the subject of the project report.

Nothing to report.

What other organizations were involved as partners?

If there is nothing significant to report during this reporting period, state “Nothing to Report.”

Describe partner organizations – academic institutions, other nonprofits, industrial or commercial firms, state or local governments, schools or school systems, or other organizations (foreign or domestic) – that were involved with the project. Partner organizations may have provided financial or in-kind support, supplied facilities or equipment, collaborated in the research, exchanged personnel, or otherwise contributed. Provide the following information for each partnership:

Organization Name:

Location of Organization: (if foreign location list country)

Partner's contribution to the project (identify one or more)

- *Financial support;*
- *In-kind support (e.g., partner makes software, computers, equipment, etc., available to project staff);*
- *Facilities (e.g., project staff use the partner's facilities for project activities);*
- *Collaboration (e.g., partner's staff work with project staff on the project);*
- *Personnel exchanges (e.g., project staff and/or partner's staff use each other's facilities, work at each other's site); and*
- *Other.*

Paws for Purple Hearts

Menlo Park, California

Non-profit organization that provides and manages the service dogs, and the service animal training intervention. We have included them in this second annual report because monies were requested to defray their costs incurred in transferring two service dogs from San Diego and Virginia whose behavioral profiles are compatible with the SATI program and the original design of this project. (Two of the three PPH dogs that came into service earlier this project year proved unable to perform as needed.)

8. SPECIAL REPORTING REQUIREMENTS

COLLABORATIVE AWARDS: For collaborative awards, independent reports are required from BOTH the Initiating PI and the Collaborating/Partnering PI. A duplicative report is acceptable; however, tasks shall be clearly marked with the responsible PI and research site. A report shall be submitted to <https://ers.amedd.army.mil> for each unique award.

QUAD CHARTS: If applicable, the Quad Chart (available on <https://www.usamraa.army.mil>) should be updated and submitted with attachments.

- 9. APPENDICES:** Attach all appendices that contain information that supplements, clarifies or supports the text. Examples include original copies of journal articles, reprints of manuscripts and abstracts, a curriculum vitae, patent applications, study questionnaires, and surveys, etc.

None

Can a Canine Companion Modify Cardiac Autonomic Reactivity and Tone in PTSD

ERMS# 13046055

Award # W81XWH-15-2-0005



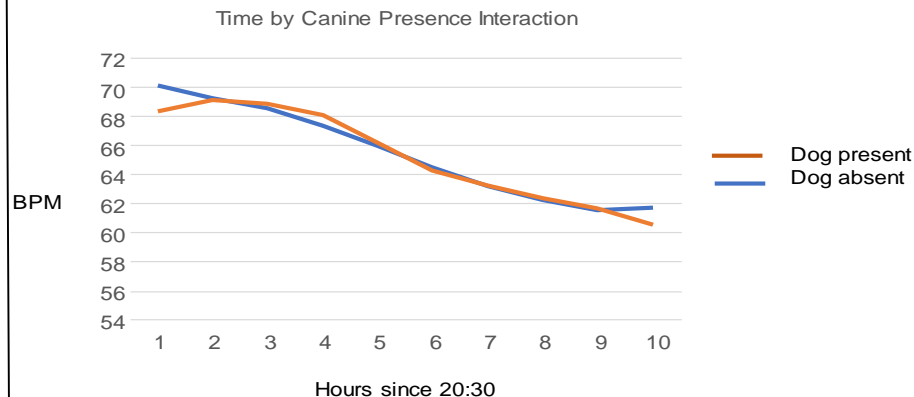
PI: Steven H. Woodward, PhD **Org:** Palo Alto Veterans Institute for Research **Award Amount:** \$1,283,573

Study/Product Aim(s)

- We propose to provide a strong test of the ability of canine-assisted therapy to mitigate recognized symptoms of PTSD that are relevant to medical and rehabilitative status. Based on studies in non-veteran, non-military samples, canine companionship may mitigate both elevated basal heart rate and poor social/interpersonal function. We will also assess the impact of canine companionship on laboratory tasks of social cognition and stress reactivity.

Approach

- We will record waking and sleeping heart rate for up to 42 days/nights in a complete sample of 60 Veterans engaged in inpatient PTSD treatment and participating in a service animal training intervention (SATI). The latter program includes extended periods both with and without the 24/7 companionship of the service animal, allowing us to use participants as their own controls. Selected between-subjects comparisons will contrast the diagnostic status' and treatment progress of SATI program participants and non-participants.



Accomplishment: Plot of the interaction of time and canine presence on sleep heart rate. Results compatible with effect of canine presence at margins of sleep period in the absence of an overall effect.

Timeline and Cost

Activities	FY	14	15	16	17
hiring, approvals, contracting, stim development and piloting, statistical consultation					
recruitment, structured interviewing, laboratory assessments, ambulatory psychophysiology, sleep actigraphy, preliminary data analyses, data archiving					
summary data analyses, manuscript prep & submission					
Estimated Budget (\$K) (direct)		\$317k	\$317k	\$325k	\$325k

Updated: 1/2017

Goals/Milestones (Example)

CY15 Goal – Complete startup tasks and commence recruiting

- ☒ all startup tasks completed
- ☒ 52 participants enrolled (vs 55 planned in SOW)

CY16 Goals – Continue accrual/ process data

- ☒ 110 participants enrolled, 97 completed (vs 104 planned in SOW)
- ☒ ongoing data processing/archiving/methods development

CY17 Goals – Continue accrual/ process data

- ☒ 153 participants enrolled, 131 completed (vs 164 planned in SOW)
- ☒ ongoing data processing/archiving/methods development

CY18 Goals – Continue accrual/ process data

- ☐ Complete enrollment/testing
- ☐ complete data analysis

Budget Expenditure to Date (through November, 2017)

Projected Expenditure:: \$959,055

Actual Expenditure:: \$845,089